TITLE

MONITORING SYSTEM

BACKGROUND OF THE INVENTION

[0001] The present invention relates to monitoring and controlling systems for interior spaces, and, in particular, to a monitoring system that can regulate the ambient humidity of interior and enclosed spaces so as to protect these spaces from damage by the environment within these spaces.

[0002] Depending on the particular building materials used in the surrounding walls of interior spaces, and depending on the potential for exposure to moisture of these spaces, practically any enclosed space can be susceptible to damage. An area very susceptible to damage caused by moisture, such as mildew and termite damage is the basement or crawl space of a house. Therefore, the ability for homeowners and/or owners of commercial buildings to maintain reduced moisture levels in the basement can be critical to preserve the structural integrity of the house, as well as to preserve the environment within the basement of the house.

[0003] Another area that is susceptible to moisture damage is the interior space of boats. In particular, the engine rooms and the interior cabins of boats that are stored at marinas can easily become mildewed, giving the boats a musty odor and damaging the materials of the boats.

[0004] Appliances for removing moisture from enclosures or interior spaces are known to prevent these areas from becoming damaged. For example, dehumidifiers are well known for use in removing moisture from the atmosphere. However, typical dehumidifiers require that a user operate the dehumidifier at the location of the unit itself. Further, the controller systems of dehumidifiers are such that the unit is either constantly running or constantly turned off. Therefore, if the user is not diligent in turning the unit on and off based on need, there is a risk that either energy will be wasted or that mildew and moisture damage will persist.

[0005] Accordingly, there exists a need for an effective and convenient system for use in monitoring and protecting areas that are susceptible to moisture damage.

SUMMARY OF THE INVENTION

[0006] The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the invention. It is not intended to identify key or critical elements of the invention or to delineate the scope of the invention. Its sole purpose is

to present some concepts of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0007] According to its major aspects and briefly stated, the present invention is a monitoring system for use in controlling the humidity within confined spaces and thereby protecting these spaces from potential moisture damage. The present invention has industrial utility in that the interior environment of commercial facilities may be optimally maintained and monitored.

[0008] In a first embodiment, the monitoring system includes a sensor for determining the humidity, moisture, and/or temperature of an area, means for communicating the humidity, moisture, and/or temperature to a first controller that is interconnected with the sensor, means for warning when the humidity, moisture, and/or temperature within the area is above a preset, desired humidity, moisture, and/or temperature, and means for adjusting the humidity, moisture, and/or temperature to approximately equal to or below the preset, desired humidity, moisture, and/or temperature. The sensor of the present invention can include a single sensor within a housing that senses one of moisture, temperature, and humidity, or, alternatively, the sensor can include multiple sensors within a housing for sensing a combination of humidity, temperature, and moisture. Further, the sensor can be either a penetrating sensor or a non-penetrating sensor. Although various alternative means can be employed to adjust the humidity, moisture, and/or temperature to a desired level, the present invention can include a dehumidification system as the adjusting means. The dehumidification system can include a dehumidifier that is connected to both the sensor and a second controller having a sensor switch that turns the dehumidifier on and off based on the ambient humidity, moisture, and/or temperature of the area in which the monitoring system is placed. Additionally, the monitoring system can include a user interface unit that is separate or remote from the dehumidifier, and that can be used to operate the monitoring system from remote locations. The user interface can include a number of inputs, as well as a service light, which indicates a need for maintenance or repair. The dehumidifier can also be connected to a plurality of fans. In larger enclosed areas, the use of multiple fans can facilitate the adjustment of humidity, moisture, and/or temperature. Furthermore, it is contemplated by the present invention that the features of the monitoring system can either be operated through standard electrical connections or through wireless connections.

[0009] In a second embodiment, the second controller of the dehumidification system can include a humidity switch and a building materials indictor switch, such as a wood moisture indicator switch. The building materials moisture switch works in combination with the humidity switch so that the dehumidifier is turned on or off either by the building materials moisture switch or the humidity switch depending on building materials moisture and ambient humidity. The building materials moisture and ambient humidity can be transmitted to the second controller by the sensor of the monitoring system either through electrical, radio frequency, or wireless transmission.

[0010] In a third embodiment, the adjusting means of the monitoring system includes a combination system having a ventilation portion and a dehumidification portion. The ventilation portion of the combination system is described in detail in U S. Patent Nos. 4,208,010 and 4,328,927. The only modification to this ventilation portion is that the louvers of the ventilator structure operate so that the louvers are open during cold weather and the louvers are closed during warm weather. The dehumidification portion can include similar features to those described in the alternative embodiments.

[0011] A feature of the present invention is the use of a monitoring system including means for adjusting humidity, moisture, and/or temperature that includes a dehumidification system in interior or enclosed spaces such as the crawl space of a house and the engine room of a boat. Not only will the use of a dehumidifier in these areas reduce and prevent the musty odor caused by potential mildew, but also the materials used to construct houses and boats can be better preserved. Further, keeping these areas dry prevents the growth of pests that can be damaging to the area, such as termites.

[0012] Another feature of the present invention is the use of a monitoring system including means for adjusting humidity, moisture, and/or temperature that includes a user interface unit in combination with a dehumidifier. Typically, dehumidifiers must be operated at the location of the unit itself. Because areas such as the basement or crawl space of a house tend to be small and unfinished, placing a unit in these areas can be unpleasant and burdensome on the user of the unit who is forced to constantly enter the basement to operate the unit. A user interface can avoid the need for entering these areas, so that a user can operate the dehumidifier in comfortable and convenient locations within the house.

[0013] Yet another feature of the present invention is the use of a monitoring system including means for adjusting humidity, moisture, and/or temperature that includes a

dehumidifier in combination with a plurality of fans. Dehumidifiers tend to include fans within the unit so that moist air is circulated into the unit and dry air is circulated out of the unit. However, if the enclosed area to be dehumidified is relatively large, the dehumidifier may take a long time to dry the air. Through the use of a plurality of fans positioned in various locations around the dehumidifier, the moist air can be more effectively dried. Further, the fans contribute to the improvement of the environment of the interior space by circulating dried and fresh air.

[0014] Still another feature of the present invention is the use of a monitoring system including means for adjusting humidity, moisture, and/or temperature that includes a second controller that is connected to a sensor and a sensor switch, wherein the adjusting means is activated or deactivated based on a preset, desired humidity, moisture, and/or temperature level. For example, if the ambient humidity is higher than the desired humidity, the adjusting means will be activated, and if the ambient humidity is below the desired humidity, the adjusting means will be deactivated. The sensor switch allows the monitoring system to remain energy and cost efficient.

[0015] The use of a monitoring system including a dehumidification system having a second controller having both a humidity switch and a wood moisture indicator switch is yet another feature of the present invention. By using a combination of switches, the dehumidification system can effectively eliminate and prevent moisture damage of the interior spaces. If the moisture contact is too high in the wood of the interior space, the dehumidifier is started. However, if only the moisture content of the air is too high, rather than the wood, then the dehumidifier is still turned on.

[0016] Yet another feature of the present invention is the use of a monitoring system including a dehumidification system having a user interface including a service alarm. The service alarm alerts the user that the dehumidification system is in need of either maintenance or repair. Therefore, the lifespan of the dehumidifier can be prolonged, and its function enhanced.

[0017] Still another feature of the present invention is the use of a monitoring system that negates the need to seal those interior spaces that are to be monitored for potential damage due to moisture. It is known that spaces, such as the basements and crawl spaces of houses, can contain levels of harmful gases, such as radon. If these spaced are completely enclosed for the sake of keeping out moisture, such gases can build up and create dangerous, harmful environments to the inhabitants of the house. The present system contributes to the circulation of fresh air throughout the space.

[0018] Yet another feature of the present invention is the use a monitoring system including means for warning when the humidity, moisture, and/or temperature within the area is the preset, desired humidity, moisture, and/or temperature in combination with means for adjusting the humidity, moisture, and/or temperature to approximately equal to or below the preset, desired humidity, temperature and moisture. This feature enables the constant monitoring of an area that is susceptible to moisture damage so as to prevent such damage. Similar to a burglar alarm system, the present invention can monitor an area from a remote location and either activate a means for adjusting the area in danger of the damage, or, alternatively, communicate the danger to a repair person who is dispatched to the area for attention to such area.

[0019] Other features and advantages of the present invention will be apparent to those skilled in the art from a careful reading of the Detailed Description of the Preferred Embodiments presented below and accompanied by the drawings

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] In the drawings,

[0021] FIG. 1 is a schematic view of a monitoring system according to an embodiment of the present invention;

[0022] FIG. 2 is a cross-sectional side view of a house containing an adjusting means of a monitoring system according to an alternative embodiment of the present invention;

[0023] FIG. 3 is a top view of the crawl space of a house containing a monitoring system including an adjusting means according to an alternative embodiment of the present invention;

[0024] FIG. 4 is a front view of a user interface unit of an adjusting means of a monitoring system according to an alternative embodiment of the present invention;

[0025] FIG. 5 is schematic view of the component parts of an adjusting means of a monitoring system according to an alternative embodiment of the present invention;

[0026] FIG. 6 is a cross-sectional side view of a boat containing an adjusting means of a monitoring system according to an alternative embodiment of the present invention;

[0027] FIG. 7 is a perspective view of an RV containing an adjusting means of a monitoring system according to an alternative embodiment of the present invention;

[0028] FIG. 8 is a cross-sectional side view of a house containing an adjusting means of a monitoring system according to an alternative embodiment of the present invention;

[0029] FIG. 9 is an exploded perspective view of a ventilator portion of an adjusting means of a monitoring system according to an alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] The present invention includes a monitoring system **1** having a sensor for determining the humidity, moisture, and/or temperature of an area, means for communicating the humidity, moisture, and/or temperature to a first controller that is interconnected with the sensor, means for warning when the humidity, moisture, and/or temperature within the area is above a preset, desired humidity, moisture, and/or temperature, and means for adjusting the humidity, moisture, and/or temperature to approximately equal to or below the preset, desired humidity, moisture, and/or temperature. The sensor of the present invention can include a single sensor within a housing that senses one of moisture, temperature, and humidity, or, alternatively, the sensor can include multiple sensors within a housing for sensing a combination of humidity, temperature, and moisture. Further, the sensor can be either a penetrating sensor or a non-penetrating sensor. As discussed, a feature of the present invention includes the use a monitoring system including means for warning when the humidity, moisture, and/or temperature within the area is the preset, desired humidity, moisture, and/or temperature in combination with means for adjusting the humidity, moisture, and/or temperature to approximately equal to or below the preset, desired humidity, temperature and moisture. This feature enables the constant monitoring of an area that is susceptible to moisture damage so as to prevent such damage. Similar to a burglar alarm system, the present invention can monitor an area from a remote location and either activate a means for adjusting the area in danger of the damage, or, alternatively, communicate the danger to a repair person who is dispatched to the area for attention to such area.

[0031] An example of an embodiment of the monitoring system **1** according to the present invention is illustrated in FIG. 1. As shown, the monitoring system includes a sensor **3**. The sensor **3** can detect the humidity, moisture, or temperature of the environment in which it is placed. Additionally, the sensor **3** can detect a combination of humidity, moisture, and temperature

[0032] Once humidity, temperature, and/or moisture is determined by the sensor **3**, this information is transmitted to a first controller **7** by means for communicating **5**. The information can be transmitted in a number of ways, including electronically, by

radio frequency through transmitters and receivers, and by wireless communication. Upon receiving the humidity, temperature, and/or moisture information the first controller 7 processes the information, and can display it for monitoring, such as on a computer screen **9**. The first controller 7 is programmed with a preset, desired humidity, temperature, and moisture, so that when information is received by the first controller 7 that indicates the temperature, humidity, and/or moisture is above the preset, desired amount, the first controller **7** activates means for warning **11**. In an embodiment, the first controller **7** can include a solid state relay. Next the warning means **11** communicates a need for an adjustment to the humidity, temperature, and/or moisture to means for adjusting **13**. Depending on whether the particular interior space being monitored includes capability for an automated adjusting means **13**, the moisture, temperature, and/or humidity can be automatically adjusted to an amount approximately equal to or below the preset, desired humidity, temperature, and/or moisture. Alternatively, the warning means **11** can communicate the need for adjustment to a repair person who will be dispatched to the area in need of the adjustment.

[0033] In an alternative embodiment, the adjusting means **13** includes a dehumidification system **10**. The dehumidification system **10** can function separately from the monitoring system **1**; however, if the activation of the dehumidification system **10** is somehow interrupted, the monitoring system **1** can be employed to assure the moisture, temperature, and/or humidity of an area is being optimized. As illustrated in FIGS. 2 and 3, the dehumidification system **10** includes a dehumidifier **12** that can be connected to a plurality of fans **14** and a user interface unit **16**. The dehumidification system **10** can be operated by a second controller **20** that can be included either within the vicinity dehumidifier **12** or the user interface unit **16**. The warning means **11** of the monitoring system **1** can be connected to the second controller **20** so as to activate the dehumidification system **10** when there is a need to adjust the humidity, temperature, and/or moisture in the particular space being monitored. The connection between the warning means **11** and the second controller **20** can be electronic, through radio frequency, or through wireless connection.

[0034] Although the dehumidification system **10** is shown to be located within a crawl space **22** or basement of a house **24**, it is contemplated by the present invention that the dehumidification system **10** can be used within any area of the house **24**, as well as other enclosed areas, such as storage sheds, RVs, and boats.

[0035] A feature of the present invention is the use of a dehumidification system **10** including the user interface **16**, which can be used to operate the dehumidification system from remote locations. As illustrated in FIG. 4, the user interface **16** can be located within the main portion of the house **24** and be electrically wired, or have a wireless connection, to the dehumidifier **12** that is in the crawl space **22** of the house **24**. Preferably, the user interface unit **16** includes a power input **3** for manually turning the system **10** on or off and a means for selecting a desired humidity **32** by which a user can incrementally adjust up and down the desired humidity of the area in which the dehumidifier **12** is located. The user interface unit **16** further includes a display **34** showing the current temperature **33** and relative humidity **37** of the area containing the dehumidifier, as well as the desired relative humidity **39**, that has been set by the user. Finally, the user interface **16** can include a service light **35** that indicates when the system **10** needs maintenance or repair.

[0036] As shown, all the components of the dehumidification system **10** can be electrically wired and can obtain power by plugging the dehumidifier into a GFI (ground fault interrupter) outlet. Alternatively, the dehumidification system **10** can be operated by remote control, wherein a transmitting device capable of transmitting signals, such as radio or microwave, communicates with a receiver so as to turn the dehumidifier **12** on or off. Therefore, the system **10** can be completely automated through these connections.

[0037] The dehumidifier **12** can include any conventional arrangement. A typical dehumidifier removes moisture from the air by condensing the moisture from the air on its cooled evaporator coils. In the present invention, the condensed moisture can be collected in a retainer beneath the dehumidifier **12**, and as shown in FIGS. 2 and 3, the condensation can drain into a pipe **40** that is routed to the exterior of the interior or enclosed space. Although a variety of dimensions are suitable for the dehumidifier **12** depending on the particular location needing to be dehumidified, the dehumidifier **12** is preferably less then 2 inches if the dehumidifier **12** is to go into the basement or crawl space of a house. Further, the dehumidifier **12** can be permanently installed next the wall of an interior space needing to be dehumidified.

[0038] A particular feature of the present invention is the use of an adjusting means **13** including the dehumidifier **12** in combination with the plurality of fans **14** that are advantageously positioned around the area needing to be dehumidified. Through the use of plural fans positioned in various locations around the dehumidifier **12**, the moist

air can be more effectively dried. Further, the fans contribute to the improvement of the environment of the interior space by circulating dried and fresh air. Preferably, the fans will pull less than or approximately 2 Amps of energy. However, more powerful fans are contemplated by the present invention.

[0039] A schematic view of how the various components of the dehumidification system **10** operate is shown in FIG. 5. As illustrated, the user interface unit **16** includes an input section **42**, including the power input **30** and the selecting means **32**, in which a user can program the desired humidity by increasing or decreasing the humidity displayed on display **34**. The user changes the desired humidity using a stepper motor **44** that allows the desired humidity to be changed in increments by sending signals to a desired humidity indicator **46**.

[0040] The programmed or pre-selected desired humidity is compared with the relative ambient humidity, which is measured by a humidity sensor **50**. The humidity sensor **50** can use any instrument for measuring atmospheric humidity, such as a hygrometer, and a thermometer **52**, because relative humidity is temperature sensitive. The humidity sensor **50** measures the actual humidity of the area in which the dehumidifier **12** has been placed. The relative humidity is also displayed on the user interface unit **16**. In operation, the desired humidity and the actual humidity are compared by a first comparator **56**. If the relative humidity is greater than desired humidity, then the dehumidifier **12** and the plurality of fans **14** are turned on, and if the relative humidity is less than the desired humidity **12**, then the dehumidifier **12** and the plurality of fans **14** are turned off. Because the dehumidification system **10**. is completely automated, a user need simply program a desired humidity and the system will thereafter operate itself to maintain this desired humidity. In an alternative embodiment, each fan of the plurality of fans **14** can include a relative humidity sensor and a desired humidity indicator so that the fans can turn on independently of the system **10** and prevent the entire system **10** failing in the case one of the fans malfunctions.

[0041] As previously discussed, the dehumidification system **10** can also include a building material moisture sensor **60** that is used in combination with a humidity sensor **50**. For example, the building material moisture sensor **60** can detect moisture in materials such as wood and plastic. Although the system **10** need only contain one of these indicators, the use of a combination of indicators contributes to the prevention of moisture damage of the interior spaces containing the system **10**. If the moisture content is too high in the building material of the interior space, dehumidifier **12** is started.

However, if only the moisture content of the air is too high, rather than the building material, then the dehumidifier **12** will still be turned on. As with the humidity sensor **50**, the actual building material moisture measured by the building material moisture sensor **60** is compared by a second comparator **64** to a pre-selected desired building material moisture, which is selected by a means for selecting a desired building material moisture **62** that allows the desired building materials moisture to be changed in increments by sending signals to a desired building materials indicator **71**, and depending on whether the actual building material moisture is higher or lower than the desired building material moisture, the dehumidifier **12** and the plurality of fans **14** are turned on or off. If the building material moisture sensor **60** and the humidity sensor **50** are used in combination, the system **10** preferably includes an "or" gate **70**, wherein the information of the first comparator **56** and the information of the second comparator **64** is sampled by a clock **72** so that the dehumidifier **12** and the plurality of fans **14** will be turned on if either the humidity or the building material moisture requires it.

[0042] The second controller **20** of the dehumidification system **10** can contain the sensor and indicator components, as illustrated in FIG. 5. However, it is also contemplated that the sensor and indicator components are removed from the controller **20** so that the controller need not remain in the vicinity of the dehumidifier **12.**

[0043] The clock **72** of the dehumidification system **10,** in addition to driving the repetition of comparisons of humidity at short intervals, also indicates on the display **34** through the service light **35** a need for a maintenance or check up of the system **10** based on preset maintenance intervals. Further, the service light **35** can also indicate that the system **10** is somehow malfunctioning and needs to be repaired. The service light **35** is advantageous because it serves a warning to the user of the system **10.** Therefore, the lifespan of the dehumidification system **10** can be prolonged, and its function enhanced.

[0044] As further illustrated in FIG. 5, the dehumidification system **10** can be connected to the monitoring system **1** through the warning means **11.** Accordingly, the monitoring system can function similar to a burglar alarm system. If the dehumidification system **10** is not activated due to a malfunctioning of any feature of the dehumidification system **10,** the warning means **11** can function to activate the system. Further, it is contemplated that each component of the dehumidification system **10** could be monitored by the monitoring system **1** so that if any one component or a combination of components malfunctioned, the warning means **11** could transmit such

malfunction back to the first controller so as to initiate repair of the dehumidification system **10**.

[0045] Figure 6 represents the dehumidification system **10** of the present invention in use in a boat **80**. In particular, the dehumidification system can be used in the staterooms or the engine room of the boat **80**. Another area to benefit from the use of the system **10** is in an RV **90**, as illustrated in FIG. 7. Both of these vehicles include many enclosed areas that may be susceptible to moisture damage. Although the system **10** in FIGS. 6 and 7 is shown to include the plurality of fans **14**, it is contemplated that the system **10** would not be required in these areas, or other small areas.

[0046] Another feature of the present invention is the use of a dehumidification system **10** in interior or enclosed spaces. Accordingly, any area that tends to become musty and mildewed is suitable for the dehumidification system **10**. Not only will the use of a dehumidification system **10** in these areas reduce and prevent the musty odor caused by potential mildew, but also the materials used in these areas can be better preserved.

[0047] In an alternative embodiment, the adjusting means **13** a combination system including a ventilation system and a dehumidification system including a dehumidifier that can be connected to a plurality of fans. The ventilation system portion of the combination system is described in detail in U S. Patent Nos. 4,208,010 and 4,328,927. The only modification to this ventilation system is that the louvers of the ventilator structure operate so that the louvers are open during cold weather and the louvers are closed during warm weather. Specifically, if the temperature is greater than approximately 6 °F, the louvers will close. FIG. 8 illustrates the combination system. In particular, the dehumidification system **10'** for use in interior or enclosed spaces is shown in combination with a ventilation system, represented by the term "VENT" **100**. As illustrated in FIG. 8, the dehumidification system **10'** portion of the combination system includes a dehumidifier **12'** that is connected to a plurality of fans **14'** and a user interface unit **16'**. The system **10'** is operated by a controller **20'** that can be included either within the vicinity dehumidifier **12'** or the user interface unit **16'**. Although the dehumidification system **10'** is shown to be located within a crawl space **22'** or basement of a house **24'**, it is contemplated by the present invention that the dehumidification system **10'** can be used within any area of the house **24'**, as well as other enclosed areas, such as storage sheds, RVs, and boats. FIG. 9 illustrates the ventilation system portion of the combination system in detail. As illustrated, the

ventilation system **100** includes a housing **110** and multiple louvers **112** that operate in conjunction with the dehumidification system **10'**.

[0048] Finally, there are many alternative embodiments and modifications of the present invention that are intended to be included within the spirit and scope of the following claims.